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ABSTRACT

A study investigated the processes used by bilinguals for organizing vocabulary by presenting subjects with bilingual word recognition tasks in two modalities (aural and visual) and using a repetition paradigm. Subjects were asked to decide whether a word presented to them was a nonsense word or a real word. Two separate experiments are described. In the first, paired words, both cognates and non-cognates, were presented aurally to subjects in both English and Dutch; some distractors were used to minimize guessing. Intralingual (same-language) repetition was used to prime subjects, and its effects were also measured. Results show a significant intralingual priming effect for each language and between languages, for both cognates and non-cognates. In the second experiment, the same material was presented visually to a similar subject group. Results indicate similar effects. Comparison of the two experiments' results suggest a model for bilingual vocabulary processing, based on a monolingual model, distinguishing three levels of vocabulary learning: word form; lemma; and lexical representation. Actions at each level are described, and interactions occurring with increasing language proficiency are examined. Experimental data analyses are appended. Contains 13 references. (MSE)

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# The organisation of the bilingual lexicon

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**Introduction**

In the empirical literature on the bilingual lexicon various techniques are reported for investigating its organisational aspects. The most commonly used technique is the **lexical decision task**. In this presentation, I will focus on a frequently used variant of this task, the so-called **repetition paradigm**. It will be explored whether this paradigm is sensitive to **modality differences** in the bilingual lexicon, that is, whether there are different experimental outcomes in bilingual tasks when the auditory modality is used, instead of the more generally used visual modality.

First, the lexical decision task and the repetition paradigm will be explained. Then some results of previous experiments will be discussed. Third, two almost identical experiments will be presented; one using the auditory modality and one using the visual modality. Finally, a model will be presented which can account for the results.

**Lexical decision task**

During a lexical decision task the subject has to decide whether the 'words' that are presented to him are real words or nonsense words. He makes this decision by pushing a button; the yes-button when it is a real word and the no-button when it is a nonsense word. This means that when a subject sees or hears the word ROSE he has to push the yes-button. On the contrary, when he sees or hears the letter sequence ACLOSTIC he has to push the no-button. A letter sequence like ACLOSTIC is called a *pseudoword*. Pseudowords are letter sequences which are well-formed according to the phonetic rules of the language in question but have no meaning in that language. So, ACLOSTIC could have been a word in English, but it is not.

In lexical decision experiments, reaction times and error percentages are typically used to test hypotheses about the organisation of and the processing in the mental lexicon.

**Repetition priming paradigm**

When the repetition priming paradigm is used, the same word is presented for a second time after several unrelated trials. Normally, reaction times are shorter on the second presentation of a word, due to the fact

that the same mental representation is accessed again. This effect is called *intralingual repetition* or repetition within languages.

In a *bilingual* repetition experiment one can also use translation equivalents at the second presentation. For instance, by first presenting the English word GARDEN and then, after several other items, its Dutch translation equivalent TUIN. When subjects now react faster to TUIN than when this word is presented in a non-primed condition, an *interlingual repetition effect* for Dutch is obtained, or, in other words, a repetition effect between languages for Dutch is obtained. Interlingual repetition effects are the result of shared representations between two translation equivalents.

More specifically, one measures an intralingual repetition effect by subtracting the reaction times on the second presentation of a word in a certain language (the intralingual condition) from the first presentation of that word in the same language (the baseline condition). To determine an interlingual repetition effect, the reaction times measured on the second presentation of a word preceded by a presentation of its translation equivalent (in the interlingual condition) are contrasted with the reaction times measured in the baseline condition.

In the literature on lexical priming an intralingual repetition effect has been found over and over again. Therefore, one should always find intralingual priming in an experiment in which between and within priming are compared. In fact, one could state that intralingual repetition priming is a prerequisite for interlingual repetition priming to be valid.

**Results previous experiments**

An interesting topic in the organisation of the bilingual lexicon is the difference between *cognate* and so-called *non-cognate* words. Cognates are words with a more or less similar form and meaning in both languages, like English HAND and Dutch HAND. Non-cognates are words which have the same meaning, but a different form in both languages, like English AIR and Dutch LUCHT.

The difference between cognate and non-cognate words is of interest since most researchers claim that repetition priming between languages is almost always found for cognates and hardly ever for non-cognates (De

Groot, 1992). For instance, Cristoffanini, Kirsner and Milech (1986), when using fluent Spanish-English bilinguals found a repetition effect for cognates but not for non-cognates. However, this position is has not gone unchallenged, since there are a number of counter examples.

First, with regard to the interlingual repetition effect of cognates, Kerkman and De Bot (1989) did **not** find a repetition effect for cognates, when their subjects were near-native Dutch-English bilinguals. Also Woutersen, Cox, Weltens and De Bot (1994) did not find an interlingual repetition effect for cognates for near-native standard Dutch-Maastricht dialect subjects. These researchers claim that these findings have to do with the proficiency level of the subjects. When subjects are very highly proficient, the lexicons of the two languages will be separated, and therefore there will be no repetition priming effect for the cognates.

Put together with the results of Cristoffanini *et al.* (1986), the conclusion can be made that in a repetition experiment using the lexical decision task, for highly proficient bilinguals there will be no repetition effect at all for cognates, neither for non-cognates, and that for intermediate proficient bilinguals, there will only be a repetition effect for cognates and not for non-cognates.

Second, with regard to the lack of an interlingual repetition effect for non-cognates, Woutersen *et al.* (1994) did find an interlingual repetition effect for non-cognates. That is, in addition to the near-native standard Dutch-Maastricht dialect bilinguals I mentioned before, Woutersen *et al.* have examined Dutch learners of the Maastricht dialect, subjects with a somewhat lower proficiency. A complicating factor in both these experiments was that auditory stimuli had to be used, since the Maastricht dialect has no written form. Most interestingly, in the experiment with the Dutch learners of the dialect, interlingual repetition priming was not only found for cognates, but **for non-cognates as well**.

A possible explanation for these results can be found in the fact that an auditory version of the repetition priming paradigm was used. Since most research using bilingual repetition tasks is based on visual word recognition, the modality difference could be the explanation for the deviating results. This explanation is strengthened by the fact that De Bot,

Cox, Ralston, Schaufeli and Weltens (1995) have reported a repetition priming effect between languages for non-cognates too. De Bot *et al.* also used an auditory version of the repetition paradigm. There subjects were very proficient Dutch-English bilinguals. These researchers claim that their result may be due to the fact that different processing strategies are which depend on the modality. This view could be extended by the claim of Kirsner, Milech and Standen (1983). In an repetition experiment, these researchers not only found priming effects for visually primed visual stimuli, but also for auditorily primed visual stimuli, which lead them to conclude that there is an amodal system in addition to the modality specific visual and auditory systems.

Coming back to the different results concerning auditory and visual word recognition, this could mean that during auditory processing, when the auditory system is active, processing strategies are used that are different from the strategies used during visual processing, when the visual system is active. I will call this hypothesis the *modality hypothesis*.

However, the differences between the auditory and the visual results could also be due to the fact that the bilinguals in the auditory experiments were of a different proficiency level than the bilinguals in the visual experiments. In this case, the bilinguals of the auditory experiments would be of a level between the intermediate proficient and the near-native level, which could be called the *very proficient* level. For bilinguals of this level there would be repetition priming effects for both cognates and non-cognates. This will be called the *proficiency hypothesis*. This would lead to following scheme: for intermediate bilinguals, there is only priming for cognates and not for non-cognates; for very proficient bilinguals there is priming for both cognates and non-cognates; and for near-natives there is no interlingual priming at all, neither priming for cognates nor for non-cognates.

In the research I am doing, both the modality hypothesis and the proficiency hypothesis will be compared. In this presentation, I will focus on the modality hypothesis. In order to do so, two English-Dutch experiments were carried out, that is, an auditory repetition experiment and a visual repetition experiment. In both experiments the *same* stimuli were used, namely cognates and non-cognates,

also the *same* kind of subjects were used, namely very proficient Dutch-English bilinguals.

If the modality hypothesis is true, in the auditory repetition experiment interlingual repetition effects will be found for both cognates and non-cognates, while in the visual repetition experiment only an interlingual repetition effect will be found for the cognates and not for the non-cognates.

In the future, I will carry out some additional experiments in order to investigate the proficiency hypothesis.

## EXPERIMENT 1

### The auditory repetition experiment

In this experiment I used a lexical decision task with repetition priming. The stimuli under investigation were cognates and non-cognates, that is, stimuli of the kind HAND/HAND and stimuli of the kind GARDEN/TUIN. In addition, the subjects had to react to some filler words, like ROSE or BOOM (meaning tree). The filler words are inserted to prevent the subjects from guessing how the stimuli under investigation were related. Furthermore, for the purpose of the lexical decision task, a large number of pseudowords like ACLOSTIC were added. In this way, the subjects also had to make no-responses.

The stimuli were presented to the subjects in blocks, two in English and two in Dutch. I measured intralingual repetition priming for Dutch and for English. The interlingual repetition priming effect was examined from Dutch to English and from English to Dutch. Within each block, the stimuli were randomized. In addition, the sequence of the blocks was rotated.

The stimuli were presented to the subjects by headphones.

*Results*

A significant intralingual repetition effect for both stimulus languages was obtained. This means that the precondition for a between language repetition effect to appear was fulfilled.

I also found a repetition effect between languages. There were no interactions. This means that there was as much priming between languages in English as in Dutch, and that there was an equally large interlingual repetition effect for the cognates as for the non-cognates (see Figure 1).

## EXPERIMENT 2

### The visual repetition experiment

In the visual repetition experiment the same material and kind of subjects were used as in the auditory experiment. The only difference was that the stimuli were not presented by headphones, but on the screen of a computer. Again I was interested in the repetition effect between languages for cognates and non-cognates.

*Results*

First, in the visual experiment a significant within repetition effect was found for both English and Dutch. Second, a repetition effect between languages was found. In this experiment too, I did not find any interactions between the between language repetition effect and stimulus language or word type. This means that there were no differences in priming between the two stimulus languages and that there was as much between language repetition for the cognates as for the non-cognates (see Figure 2).

Finally, an overall analysis which included both experiments was carried out. This analysis showed that there were no differences in interlingual priming between the auditory and visual modality.

The only small difference I found was the fact that in the auditory task the reaction times were about 120 ms longer for the English stimuli than for the Dutch stimuli. This can be explained by the fact that the English stimuli were roughly 170 ms longer than the Dutch stimuli, due to the fact that the speech rate of the Dutch speaker was much faster than the speech rate of the English speaker.

### Discussion

In both experiments the same main effects were found. There were no differential effects for the variable stimulus language. In both experiments repetition priming between languages was not only found for the cognates but for the non-cognates as well. Moreover, an overall analysis including both modalities showed that there were no differences in interlingual priming between the auditory and visual modality.

On the basis of our results the modality hypothesis can

be rejected. So, no different processing strategies are used for phonology and orthography. For very proficient bilinguals there is priming for both cognates and non-cognates. This result was also found by De Bot *et al.* (1995) and Woutersen *et al.* (1994). Furthermore, for intermediate proficient bilinguals there is only priming for cognates and not for non-cognates (Cristoffanini *et al.*, 1986; Kerkman and De Bot, 1989). Moreover, at the highest level, the near-native level, there is neither priming for cognates nor for non-cognates (Kerkman and De Bot, 1989). Apparently, for intermediate proficient bilinguals the word forms form the connection between the lexical items of the two lexicons. For very proficient bilinguals word meaning is the connecting factor. Finally, for near-native bilinguals, the lexical items of both languages are organised in a more separate way, *i.e.* they are connected neither through word form nor through word meaning.

I will go on with presenting a model of the bilingual lexicon which can account for the growing proficiency of bilinguals.

## THE MODEL

The bilingual model to be described in this presentation is based on the monolingual models of Flores d'Arcais and Schreuder (1987) and Schreuder and Baayen (1994). Following the Schreuder and Baayen model *three* levels are distinguished: the word form level, the lemma level and the lexical representation level. On each of these levels there are nodes which are connected to nodes at the other levels. The connections between nodes can grow stronger and weaker according to the following principles: when nodes are frequently used together, the connections between them will grow stronger; when words are no longer used together, the connections between the nodes will gradually get weaker and finally they will disappear.

There are no separate levels for production and reception in this model, due to the fact that the difference between production and reception phenomena has to do with differences in processing and not with differences in the representations of words (Zwitserlood, 1994), Therefore the connections between the various levels are bidirectional, that is, top-down as well as bottom-up. In this way the model is suited to explain lexical processing in both reception and production.

I will first present the levels. Then, the development of the bilingual lexicon, that is, the organisational changes due to a growing proficiency level will be described.

### The lexical representation level

At the lexical representation level there are three kinds of nodes, namely *semantic* nodes, *syntactic* nodes and *language* nodes. This variety of nodes makes the lexical representation level different from the conceptual level used in earlier models, where only semantic information is represented.

The semantic nodes in my model are of a decomposed nature. So each concept consists of a number of meaning features.

The second kind of nodes are the syntactic nodes. In these nodes the syntactic functions of the lemma are specified, for instance, is it a noun or a verb, does this verb have an object or not? That is, information about word class and argument structure.

In addition to the nodes proposed by Flores d'Arcais and Schreuder, a third kind of nodes is added, the

so-called language nodes. These nodes are able to activate or deactivate languages. The principle of different activation levels for the languages of a bilingual has been proposed by Grainger and Dijkstra (1992) and Grainger (1993; see Figure 3). These researchers have constructed a computer model in which language nodes are modulating the activation levels of the lexicons.

The language nodes can handle the activation of the language as follows. Depending on the situational context a particular language node will get a certain activation level. When language *a* is used, language node *a* will be more activated; when language *b* is used, language node *b* will be more active. When language *a* is used and language *b* is likely to be used, language node *a* will be very active and language node *b* will only be activated to a certain degree.

So the language nodes have two functions: 1. They indicate to which language a certain lemma belongs. 2. They activate the lemmas of the language that is used.

**The lemma level**

The presentation of the lemma level can be rather short. At the lemma level all the information of the lexical representation level is brought together. This information is connected to a word form. This means in particular that at the lemma level the connection between meaning and word form is made. Moreover, it means that via the lemma level each conceptual/syntactic conglomeration is given its own language-specific identity.

**The word form level**

The word form level is divided into two main levels of representation, namely the *phonological* level and the *orthographical* level (Grainger & Ferrand, 1994). At the phonological level phonemes are represented. At the orthographical level graphic symbols are stored. These can vary from letters, as in English and Dutch, to characters, as in Chinese. In those languages where there are *graphemes* (graphical symbols of phonemes), the phonological and orthographical level can be related by connections which could be called *grapheme-phoneme correspondence rules*. Through these connections each phoneme is related to the grapheme(s) that represent

it. In languages where there are no graphemes the relation between the phonological and the orthographical level can only be indirect, that is, via the lemma level.

**The acquisition of the bilingual lexicon**

When a person starts to learn a second language, a language node in the L2 will be developed. This language node will be connected to all the L2 lemmas learned by that person. The L2 lemmas will also be connected to other nodes at the lexical representation level, namely the syntactic and semantic nodes. Initially, the most general lexical representations of the L1 will be taken over. This means that when an L2 word is acquired, only the core meaning and syntax of the equivalent L1 word are used. The peripheral meaning and syntax of the L1 word will be regarded as typical for the L1 and therefore will not be assigned to the L2. So a low-proficiency bilingual will have extended lexical representations for an L1 lemma from which only a subset is also connected to the corresponding L2 lemma (see Figure 4). For cognates, the picture looks the same at the lexical representation level, but in addition there will be overlap at the word form level. In a bilingual repetition task, there will be an interlingual repetition effect when there is enough overlap at one or more levels. For a low-proficiency bilingual, there will only be an interlingual repetition effect for cognates, since only at the word form level there will be enough overlap to cause a repetition effect.

As the proficiency of the bilingual develops, he will start to perceive more similarities at the lexical representation level between his two languages (see Figure 5). This will lead to more overlap at the lexical representation level for more proficient bilinguals, resulting in an interlingual repetition effect for cognates and for non-cognates, that is, priming of word meaning is strong enough to produce a repetition effect.

Finally, when a bilingual becomes even more proficient, that is, of a near-native level, he will learn more about the specific meaning and syntax of the L2 words. Therefore, specific L2 representations will be developed and presumed similarities between L1 and L2 will be dropped, due to the fact that these nodes are no longer used together. This means that a

high-proficiency bilingual will not only have extended lexical representations in the L1 but also in the L2. Only the core representations will be shared by the two languages (see Figure 6). In the same way, there will be less overlap at the word form level than for lower proficiency bilinguals. So for near-native bilinguals, there is a relatively small amount of overlap between the words of the two lexicons, not only at the lexical representation level, but also at the word form level. Therefore, there will be no repetition priming, neither for cognates, nor for non-cognates.

In addition this model is able to describe individual differences in the acquisition of words and the different acquisition rate of production and reception skills.

It is for instance possible that a word in the L2 already starts with specific lexical representations. Whether this happens or not depends on the context of acquisition. When for example a Dutch learner acquires the English word *taxi* in London, there will, in addition to the core representations, which are the same in both languages, immediately be specific meaning components attached to the lemma. For instance the fact the London taxi is black. The occurrence of specific meaning components will lead to a relatively smaller number of shared nodes between the lexical representations of L1 and L2.

As for the difference between production and reception, during language acquisition reception skills are developed first and production skills only later. Therefore, in the model the connections between the lemma and the lexical representation level will first develop in the direction from lemmas to lexical representations. Later on the connection from lexical representation level to lemma level will develop. In other words, in the beginning the connections will be stronger in the reception direction than in the production direction, which will lead to faster selection during reception than during production. As a consequence, for low-proficiency bilinguals there will be larger retrieval differences between reception and production than for high-proficiency bilinguals.

**Concluding remarks**

In this presentation I have compared two repetition experiments, an auditory and a visual one. I concluded

that there were no differences between the two modalities and that the differences between my experiments and the ones described in the literature must be the result of proficiency differences between the bilinguals. In addition, I have presented a model of the bilingual lexicon which can account for these proficiency differences between bilinguals.

However, as this model is still worked on, and I am looking for improvement, I would like you all to give your comments.

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**Interlingual repetition effects**

| *researchers* | *proficiency/subjects* | *cognates* | *non-cognates* | *modality* |
|---|---|---|---|---|
| Cristoffanini et al. (1986) | highly fluent Spanish-English | + | - | V |
| De Bot et al. (1995) | very proficient Dutch-English | + | + | A |
| Woutersen et al. (1994) | very proficient Dutch-dialect | + | + | A |
| Woutersen et al. (1995) | very proficient Dutch-English | + | + | A |
| Woutersen et al. (1995) | very proficient Dutch-English | + | + | V |
| Kerkman & De Bot (1989) | near-native Dutch-English | - | - | V |
| Woutersen et al. (1994) | near-native dialect-Dutch | - | - | A |

| STIMULI | LANGUAGE | |
|---|---|---|
| | **English** | **Dutch** |
| cognates | *hand* | *hand* |
| non-cognates | *garden* | *tuin* |
| filler words | *rose* | *boom* |
| pseudowords | *aclostic* | *wunder* |

| CONDITION | | REPETITION EFFECT |
|---|---|---|
| **baseline** | **repeated** | |
| Dutch | Dutch | intralingual |
| English | Dutch | interlingual |
| English | English | intralingual |
| Dutch | English | interlingual |

Figure 1: Repetition between languages (auditory task)

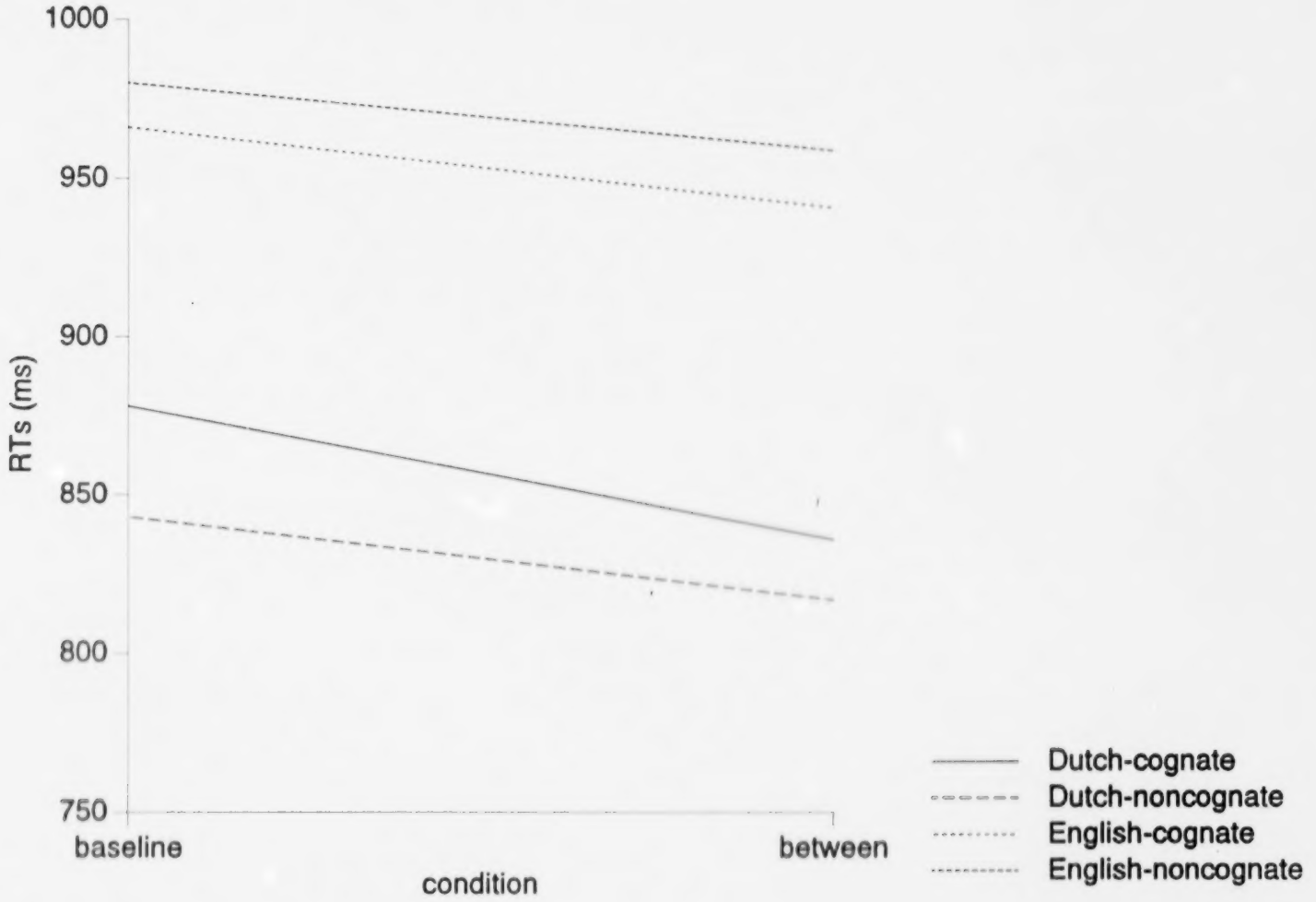

Figure 2: Repetition between languages (visual task)

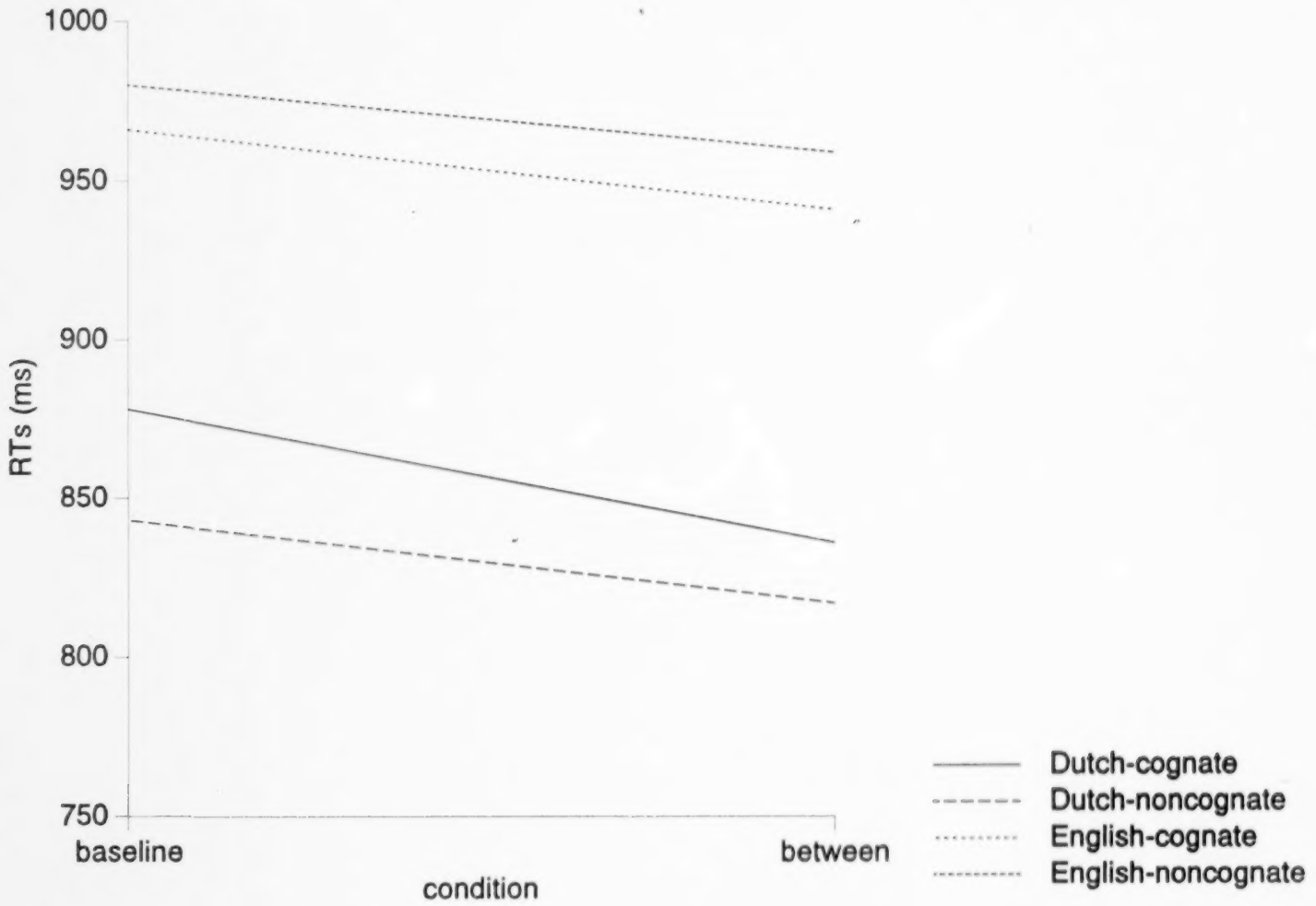

Figure 3: The Grainger and Dijkstra model (Grainger, 1993)

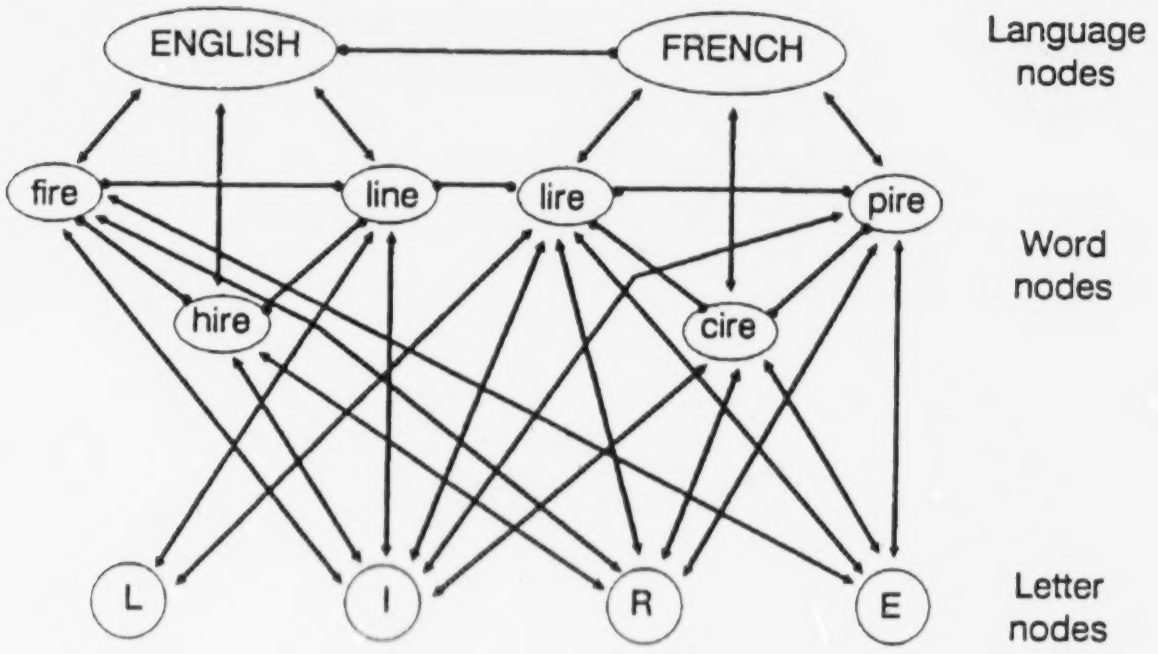

Figure 4: Example of a low-proficiency bilingual's non-cognate.

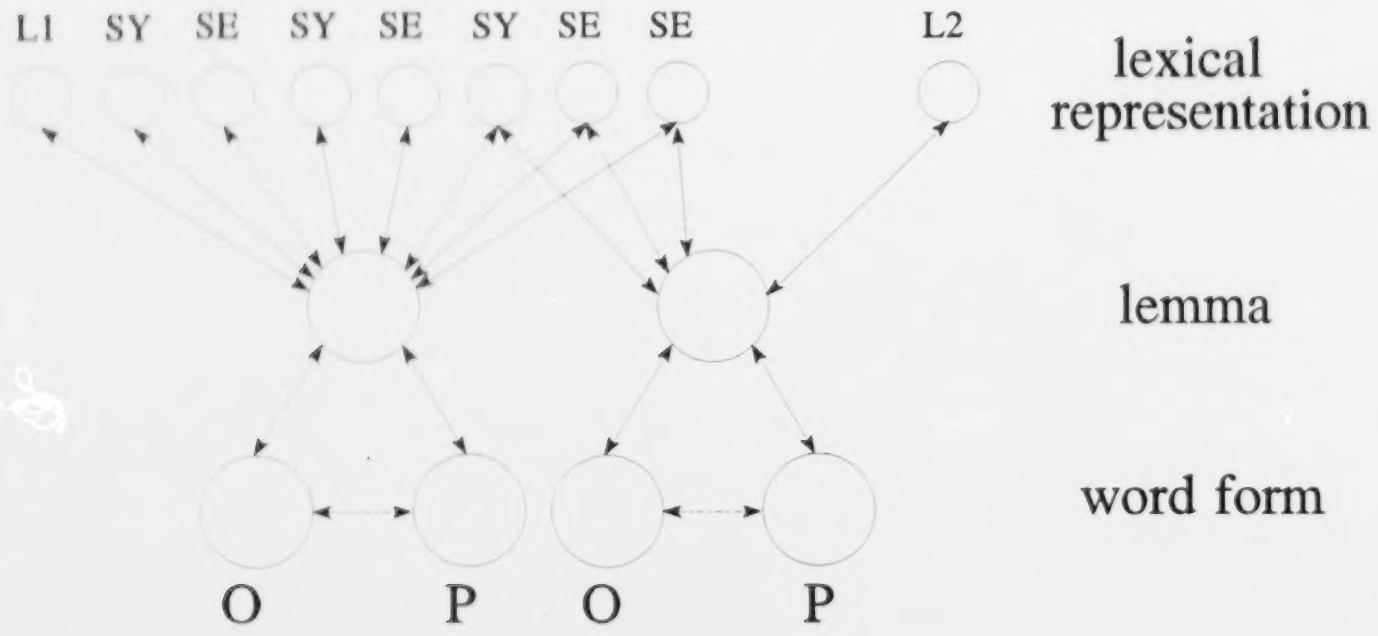

Figure 5: Example of a intermediate proficiency bilingual's non-cognate.

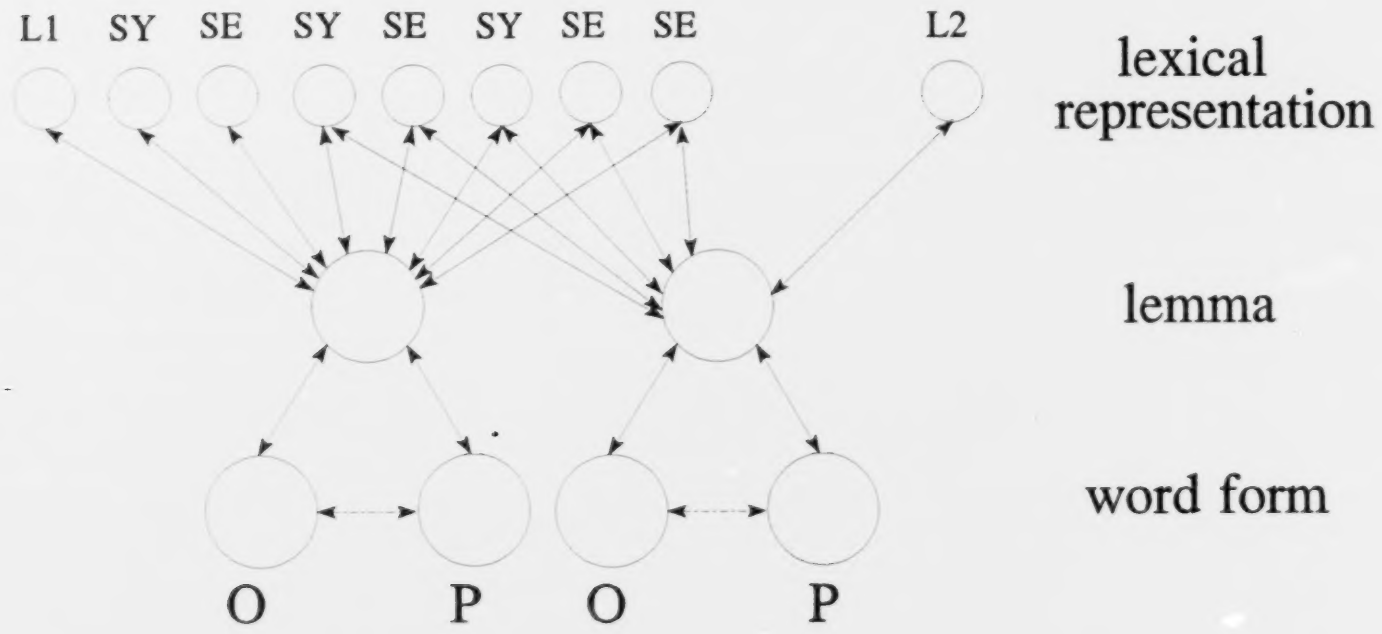

Figure 6: Example of a high-proficiency bilingual's non-cognate.